

**The Implementation and Effectiveness  
of  
Geographic Information Systems  
Technology and Methods  
in Secondary Education**

**by  
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The Implementation and Effectiveness of Geographic Information Systems

Technology and Methods in Secondary Education

Dissertation directed by Professor A. David Hill

Geographic information systems (GIS) technology and methods have transformed decision-making in universities, government, and industry by bringing digital spatial data sets and geographic analysis to the desktop computer. Some educators consider GIS to be one of the most promising means for implementing educational reform. However, GIS technology has been adopted by only 1% of American high schools. The reasons behind the interest in GIS technology and methods, their slow implementation, their extent in the curriculum, and their effectiveness in teaching and learning are unclear.

To address these concerns, this research: (1) describes the geographic and curricular extent to which GIS technology and methods are being implemented in secondary education in the United States, (2) explains why and how GIS is being implemented, and (3) assesses the effects of inquiry-based lesson modules that use GIS technology on teaching and on the acquisition of standards-based geographic content and skills. A survey of high schools that own GIS software provided primary data to describe and explain the extent of the implementation. A set of pre- and post-test experiments and case studies in three Colorado high schools provided primary data for assessing the effects of GIS.

GIS provides the opportunity for issues-based, student-centered, standards-based, inquiry-oriented education, but its effectiveness is limited

primarily by social and structural barriers. Technological barriers to the adoption of GIS, such as limited hardware and software, were found to be less significant than time required to develop GIS-based lesson modules, inadequate student access to computers, inadequate training, and pressure to teach a given amount of content during each term. GIS is being implemented primarily by veteran science teachers at public high schools who perceive that GIS provides real-world relevance, provides interdisciplinary education, and increases student interest. These teachers persist in developing and implementing inquiry-based GIS-based lesson modules despite perceived lack of time and training. Results of experiments with standardized and spatial analysis tests were mixed, although students using GIS performed significantly better on their assignments than those using traditional methods. Case studies showed that GIS changes teacher and student roles, communication, and methods of teaching and learning.

## **Acknowledgments**

It is good to have an end to journey towards,  
but it is the journey that matters in the end.

--Ursula LeGuin

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I thank the over 400 teachers who responded to my GIS in education survey. However, those who served as my case study teachers deserve special recognition. While they must remain anonymous for this dissertation, they are outstanding individuals who welcomed me into their classrooms and answered all of my questions. I take responsibility for any errors in documenting the case studies and analyzing the national survey and experiments. It is my hope that I showed the high school students I worked with that learning is not only imperative, but it's OK to get excited about it!

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I close with two quotes; the first of which summarizes my respect for educators:

"If the heavens were all parchment, and the trees of the forest all pens, and every human being were a scribe, it would still be impossible to record all that I have learned from my teachers."

--attributed to Jochanan Ben Zakkai. First century A.D. rabbi, teacher, and sage.

and the second:

For with God, nothing shall be impossible.

--*The Bible*, Luke 1:37.

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*“The trouble with education...  
is that the best teaching methods are in fact the most difficult.”*  
--Piaget 1929<sup>1</sup>

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<sup>1</sup> Piaget, Jean. 1929. *The Child's Conception of the World*. London: Routledge.